

prey, the polinices and naticas depend on drilling a hole in one of the valves, generally near the hinge. I could go on giving examples of variation of the fauna present at different times, but I will just mention one more, *Turritella goniostoma*. In February and May of previous visits they were almost non-existent there except for the empty shells many of which had drilled holes showing their fate, but this year in January, in San Carlos Bay, they were spawning, and from a dozen up would be crawling in a limited space. They deposit a gelatinous string a half inch in diameter and more than twelve inches long, throughout which the large eggs show plainly.

There is no doubt that mollusks, like fishes, migrate to their spawning grounds, thus accounting for their absence or abundance at various seasons. But this is not always understood by amateur collectors who often complain about their lack of luck.

Much could also be said about the ecology of the different species. Some dwell on the sea floor, some on or among the rocks, and some in the sand. But that would be another story.

OBSERVATIONS UPON A FLORIDA FORM OF VIVIPARUS

By CALVIN GOODRICH

Mr. T. Van Hyning of the Florida State Museum recently sent me *Viviparus georgianus* form *walkeri* (Pilsbry and Johnson), containing soft parts, that had been taken in Sante Fe River, Alachua County, Florida, on May 22, 1941. It was a simple matter to separate the sexes—in the case of females mostly by the presence of ova and embryos, in that of the males by the tentacles, one of which is a generative organ. The sending was made up of 447 specimens. The females numbered 358, the males 89. This is almost exactly four females to one male, or put another way, 80.0 per cent females and 19.9 per cent males.

In the course of a detailed study of *V. bengalensis* (Lamarek), Annandale and Sewell (1921) found that the sexes of a single year's brood were "roughly" four females and one male. A report upon *V. crassus* (Hutton) from which these authors quote

gives a ratio of approximately three females to two males. Van Cleave and Lederer (1932), using *V. contectoides* Binney as their material, met with a similar ascendancy of females over males in seven samples. In two other samples, however, there were more males than females. In the whole nine samples, the ratio of females to males varied from 0.28:1 to 3.38:1.

Still, the authors are not inclined to believe the sexual inequality to be the rule. "From all the data before us," they have written, "it seems that at birth the two sexes are present in equal numbers. By midsummer the longer life span of the females [which they were able to demonstrate] has the cumulative effect of producing a preponderance of females in the ratio of 1 male:1.3 or 1.4 females. By late fall or midsummer the older males die off, leaving the young males of the preceding period of parturition. By this elimination of males, the cumulative effect of simultaneous existence of two or three generations of females continues to magnify the advantage of the females in the ratio until there may be two or three females to a single male. This condition persists until the following spring, when the new brood, again with equivalent numbers of the two sexes, brings back the male ratio to the proportion characteristic of midsummer."

It might well be that the sexual disproportion observed by several persons, including Van Cleave and Lederer, has been due to faulty sampling or collecting, to differences in viability or even to a certain habit of secretiveness on the part of the males. Yet before that is admitted without dispute, two facts, surely having a bearing on the case, should be considered. One is that *Campeloma*, related to *Viviparus*, has a sexual inequality, that is admitted and notorious, and is wholly convincing to anyone who sets out to find a male; the other, that the anatomy, and hence the physiology, of a freshwater genus of gastropods are much alike. So a sexual disproportion in *Campeloma* tends to support a belief in real sexual disproportion in *Viviparus*.

That females in *Viviparus* reach a greater size than males has been noted by Annandale and Sewell as also Van Cleave and Lederer, and the former authors pointed out that this was observed by Lister in 1695 in the instance of *V. viviparus*. Exact measurements of the height of *V. georgianus* form *walkeri* could

not be made because the spires of all the older shells of the Van Hying sending were eroded. As an alternative, an index of obesity was calculated by dividing the height of the last three whorls by the diameter. In twenty females, the average index was 86.1 per cent; in twenty males, 87.4. It would appear from this that proportionally males were about as obese as females. Nevertheless, the diameter of the largest female was 24 mm., and that of the largest male 20.50. As Call (1888) learned that female *Campeloma subsolidum* (Anthony) was larger than the male shell, thirty-six specimens of each sex being chosen for measurement, it may be suspected that a greater gross bulk in females over males is common throughout the Viviparidae. The smallest female *walkeri* from Sante Fe River that was found with eggs was of four whorls, the spire entire. Its altitude was 20 mm., diameter 17.50 mm. In all likelihood it had come to sexual maturity and was bearing young within a year of its own birth.

Eighty-eight eggs and embryos were counted in a female *walkeri*. This may be compared with findings by Crabb (1929) of 130 eggs in a specimen of *V. contectoides* and an average of eighty-six plus in eight examples of introduced *V. malleatus*. As the marsupium of *Viviparus* is a sort of assembly line starting with undeveloped ova, grading to embryos and then on to young ready for discharge, the line sometimes crowded and sometimes not, such counts, one may suppose, are bound to vary a great deal. *V. contectoides* under the observation of Dr. Crabb was discharging eggs and embryos at the end of March. Females of *walkeri* gorged with eggs and juveniles were collected about two months later than this. Van Cleave and Lederer learned that "the most active period of liberating young" *contectoides* "seems to fall in the months of March and April in central Illinois" and, in New York, "from some time in March to June." As young of the Florida shells taken in May were ready for liberation, if actually some had not been going through that course already, it is perhaps impossible—on the basis of data from four widely separated localities—to be confident that climatic conditions decide the times of discharge. Very young embryos of *walkeri* are thin, crystalline white and transparent; those about to be extruded dark reddish brown and relatively thick. No trace of revolving color bands

was seen in any of the embryos, but this may have been due to the preserving liquid which first was formalin and then alcohol. The largest measured embryo was of three and one-eighth whorls and had a diameter of 6 mm., an altitude of 4.30 mm.

A generic character of *Viviparus* is a row or rows of epidermal elevations broken into projections that sometimes are of such prominence as to constitute bristles. Embryos of *walkeri* two whorls in size have ten to twelve such lirations above the periphery, as many or more below it which are less sharply defined. Forty-five of these lines were counted in an adult example. It required manipulations of lighting on Dr. Annandale's part to make out ridges in the shell material of *bengalensis* corresponding to those in the epidermis, but in several individuals of *walkeri* this basic sculpture proved to be quite plain even without magnification. Recently, *Campeloma* of some upper Michigan localities was found to retain lirations into adolescent age just as *V. walkeri* of Sante Fe River does much longer. It may be that environmental conditions govern in the matter.

Of the 358 females of *walkeri*, 242, or 67.6 per cent, had revolving color bands. The rest were without signs of them. The banded males were 62, or 69.6 per cent of this sex. Seemingly, then, there is no correlation between sex and banding. The shells having the deepest ground color were the very young to those half-grown. This color tends to fade in the mature and there is besides some reduction of pigmentation which is due to abrasion.

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